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Maintenance Performance Indicators for Technical Support Organizations

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Abstract

The purpose of this paper is to present the IRSN approach to define a set of maintenance performance indicators (MPI) dedicated to technical support organizations and not depending on maintenance strategies chosen by utilities. The set of MPI which is in progress at IRSN, the technical support of the French regulatory body (ASN), in order to assess NPPs maintenance performance from a safety point of view, is proposed.

Keywords – maintenance, performance, indicators, characteristics, approach, structure

Introduction

As part of its mission as expert adviser to the Nuclear Safety Authority, the Nuclear Safety and Radiological Protection Institute (IRSN) examines operations that could affect the safety of the EDF nuclear facilities. Within this framework, IRSN has developed various methods for analyzing operating experience feedback and for measuring the effectiveness of the maintenance. The indicators are an addition to all the other tools available to assess the maintenance of the EDF facilities (58 units).

Framework of Maintenance Performance Indicators

Economic deregulation of electricity markets in many countries has placed nuclear power plants in a new competitive environment. In this context, the aims of the French operator are to optimize the maintenance strategy, to enhance the maintenance efficiency and to monitor the performance, to increase the availability of its nuclear power plants.
It is for this reason that, after the development and the implementation of various maintenance methods, EDF decided to adapt and implement an INPO method, the AP-913 method (based on the Reliability Centered Maintenance (RCM) principles). This method was developed for the American nuclear power plants to improve the reliability of the Structures, Systems and Components (SSC) and thus the availability of nuclear power plants.

A maintenance policy is fundamental for the safety level of the nuclear power plants (NPP). It is also important to be able to measure the effectiveness of this maintenance from a safety point of view. Several tools are available to measure this performance and in particular maintenance performance indicators (MPI). The definition and the development of this type of indicators are commonly used by

operators worldwide. But it is also essential for nuclear authorities and technical support organizations (TSOs) to develop some MPI in order to have their own point of view on the maintenance performance in the NPP and the impact on the safety level.
Approaches by indicators are largely used for the assessment of the maintenance of the nuclear power plants. However, it raises the following questions: is it possible to develop a set of maintenance performance indicators dedicated to TSOs for the evaluation and the optimization of maintenance on a safety point of view? Is it possible to define a MPI set which does not depend on maintenance strategies chosen by utilities but rather on the specific interests of each stakeholder?

Objectives of the study

The overall objective of this study is to analyze the operational state-of-art in many countries and international organizations (IAEA, EU…), and carry out the necessary research tasks in order to develop optimized organizational and technical models to be proposed to technical support organizations as contributions to the harmonization of the operational practices.
The different tasks defined in the study were focused on the analysis of the existing practices in relation to maintenance performance in nuclear and non-nuclear industries, and on the development of a comprehensive list of indicators that can be used by NPPs for the evaluation of their own maintenance programmes or a list of indicators that can be used by regulators for the monitoring of the requirements.
The work at this step can not produce a MPI set for TSO, or a MPI set directly dedicated to a TSO. In fact, the existing literature around this topic is only dedicated to operators or regulators.
These tasks allowed to suggest a framework for maintenance performance indicators program and to provide guidance for the implementation of a MPI system.

Maintenance Performance Indicators set

A. Objectives of maintenance performance indicators

The goal of NPP maintenance is to allow nuclear operators to keep all functions necessary for safe and reliable power production functional but also available and reliable. Plant maintenance includes the aspects of both safety and economy. Our study doesn't take into account the economic aspect of maintenance.

Maintenance activities in NPPs are traditionally performed during planned refuelling and maintenance outages. Outages are very important in this study and very well documented because they are the main reason of the plant unavailability and it is a well known fact that the outages involve a substantial Operation & Maintenance (O&M) budget.
According to the competitive context, a nuclear power plant has to be safe, reliable and cost-effective. So, one consequence of this situation is to succeed, at the same time, in reducing the operational and maintenance budget and in increasing plant availability while continuously meeting as strictly as possible safety requirements. This situation encouraged many NPPs to develop MPI to measure the effectiveness of their maintenance and the regulatory bodies to evaluate the safety requirements in the maintenance area.
For a TSO, it is important to have a similar tool in order to have an overall view of the NPP maintenance to monitor that the utility maintains, and improves where possible, the safety level despite the competitive context and the cost reduction. It is for this

reason why IRSN deems that TSOs need to develop their own MPI system. This tool does not depend on maintenance strategies or policy chosen by utilities or the allowed maintenance budget but only on the results on the required safety level.

The maintenance performance indicators should give as faithfully as possible an image of the whole maintenance process of nuclear plants (during outage or not) from a safety and radiological protection point of view. They should ultimately be used to assess performance degradations or improvements in terms of safety (for instance performance of safety functions, equipments, organization, etc.), in order to point out their potential effects within the shortest time.

The maintenance performance indicators provide an outline of what is important for the maintenance from a safety and radiological protection point of view. These indicators relate directly to safety, radiological protection and releases. They are an addition to all the other tools available to assess the maintenance of the EDF facilities (58 units). They should highlight any trend that combines with other information and analysis sources to provide us with lessons on safety issues.

The maintenance performance indicators are intended to:

- Perform a permanent watch on the maintenance effectiveness of the facilities,
- Identify trends in significant safety aspects and, if appropriate, detect degradations sufficiently early to warm the French utility and the French Safety Authority,
- Assess plant homogeneity and highlight any disparities and specific features between plants.

B. Selection of MPI set

The first step for the establishment of a MPI program is the selection of the maintenance performance indicators.
The primary basis for selection is the availability of data for the evaluation of indicators. To this end, each proposed indicator should be looked at to evaluate the data requirements. Once the data requirements are identified, then it is clear what indicators can be used.
At this step, a TSO should run into the difficulty of implementing a MPI system. Due to the fact that a TSO, on the contrary of the facilities, does not have access to all the data and certain data are provided by the facilities in the form of for example average of systems unavailability… which is not suitable for the evaluation of the concerned indicators. Therefore, some indicators, although relevant for the system, cannot be calculated.
However in the process of system development it is reasonable to look for new indicators to cover the concerned maintenance aspect.

C. Characteristics of MPI set

In the implementation of a maintenance performance monitoring program, consideration should also be given to the quality of the information that each indicator provides.
In 2000, IAEA identified a set of ideal characteristics of operational safety indicators [1]. Some of these characteristics are selected for maintenance:

- direct relationship between the indicator and maintenance;
- necessary data are available or capable of being generated;
- indicators are quantitative data;
- indicators are unambiguous and should be applicable to all the units;

- their significance is understood;
- they are not susceptible to manipulation;
- they can be validated;
- they can be linked to the cause of a malfunction;
- the accuracy of the data at each level can be submitted to quality control and verification.

D. Structure of MPI set

The goal to aim with the maintenance monitoring system is maintenance excellence. The stakes for a TSO within this framework are to assess a maintenance level capable to maintain or enhance the safety level of the NPP by warming of the existing or potential deficiencies. Although the budget allowed to maintenance has an important concern, its impact is measured in an indirect way.

Maintenance Excellence forms the top of the maintenance performance hierarchical structure proposed, from which three maintenance families (two families, already in place and one in progress) are developed; these are associated with the excellence of the maintenance programme:

1. Preventive maintenance;
2. Maintenance management (including Outage management);
3. *Generic and design deviations (in progress)*.

These three families are not assessable directly; therefore, the maintenance performance indicators structure was expanded until the level of easily measurable quantitative metrics. Using the families as a starting point for the indicators system development, a set of maintenance performance indicators was proposed in Figure 1.

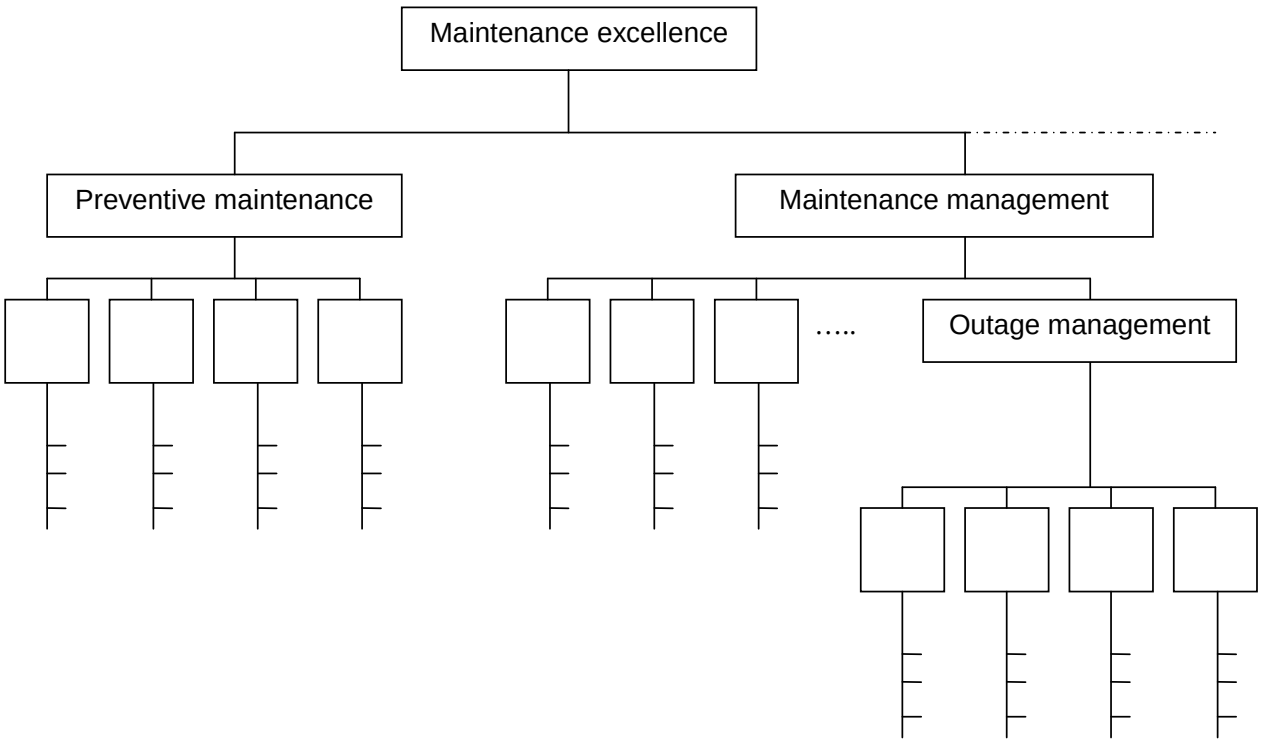

Figure 1: Structure of maintenance performance indicators set

The family "Preventive maintenance": preventive maintenance is scheduled actions to prevent the failure of systems or components according predetermined intervals or required criteria. The objective of preventive maintenance is to maintain a low probability of failure or degradation of the operation of equipment and consequently to maintain the safety level. Preventive maintenance programs are established at nuclear facilities to maintain equipment within design operating conditions and/or to extend equipment life. The use of the preventive maintenance programs contributes to the security of the plant personnel and the quality of the intervention performed. This is because the preventive maintenance activities are planned in advance facilitating the control of backlog at a reasonable level. Preventive maintenance should be performed in particular on equipment for which failure will damage the safety level and reliability of operation or may result in forced outages.

For the family "Preventive maintenance", the sub-family "Reliability of systems and components" is proposed. Three MPIs are proposed in this sub-family, for example, the MPI "Number of failures in safety related systems" or the MPI "Number of corrective work orders issued". The sub-family "System and component availability" is also proposed in this family.

The family "Maintenance management": the maintenance management program makes it possible to guarantee that the activities can be correctly scheduled and carried out by plant personnel or service providers, according to adequate procedures, performed at the appropriate time with a controlled quality. The maintenance management system should ensure the accurate planning of the tasks, the right allowance of the resources according to the tasks and competences, an adequate document management, an adequate traceability of information… Well-planned, correctly scheduled and with an effective communication maintenance activities make it possible to achieve a larger number of tasks in a more efficient way. This work will disturb operations less frequently, and will be accomplished with higher quality, greater job satisfaction and in a better organization than the works carried out without proper preparation.

For the family "Maintenance management", the sub-families "Interface with operations", "Safety during maintenance intervention", "Material management" and "Radiological protection and Security" are proposed for example.
The MPI "Number of temporary modifications" is an indicator of the sub-family "Interface with operations" and the MPIs "Number of fire hazard events", "Number of radiological protection related events during maintenance intervention" are indicators of the sub-family "Radiological protection and Security".
In the sub-family "Outage management", MPIs concerning "Planning and Scheduling", "Work control and quality" … are proposed.

E. Determination of the thresholds for MPIs
One of the important and also difficult tasks dealing with the effective use of the MPIs is the definition of thresholds for indicators.
The specific thresholds and target values for MPIs may be developed using expert advisory process. In this process a special questionnaire has to be developed to collect expert judgement on specific values for the thresholds; then the results will be statistically processed and averaged. This task is in progress.

Summary & Conclusion

Maintenance strategies developed for structures, systems and components of NPPs are based rather on a risk-informed approach than on a reliability-centered policy. The proposed approach tries to present a tool which is not depending on the choices of the utilities but on the specific interests of technical support organizations. The main concern is the impact of the maintenance on the safety level by an independent assessment of the maintenance efficiency performed on nuclear power plants. The development of this tool for a technical support organisation is in progress at IRSN. Some limits and difficulties are already established like the data availability, the thresholds’ determination for MPIs.

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